# Volunteer Lake Assessment Program Individual Lake Reports
## WARREN LAKE, ALSTEAD, NH

**MORPHOMETRIC DATA**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Watershed Area (Ac.): | 3,237 | Max. Depth (m): | 4.2 | Flushing Rate (yr¹) | 4.2 | | |
| Surface Area (Ac.): | 185 | Mean Depth (m): | 2 | P Retention Coef: | 0.57 | | |
| Shore Length (m): | 5,500 | Volume (m³): | 1,503,500 | Elevation (ft): | 1200 | | |

**TROPHIC CLASSIFICATION**

| Year | Trophic class |
|---|---|
| 1991 | OLIGOTROPHIC |
| 2005 | MESOTROPHIC |

**KNOWN EXOTIC SPECIES**

The Waterbody Report Card tables are generated from the DRAFT 2014 305(b) report on the status of N.H. waters, and are based on data collected from 2004-2013. Detailed waterbody assessment and report card information can be found at www.des.nh.gov/organizations/divisions/water/wmb/swqa/index.htm

| Designated Use | Parameter | Category | Comments |
|---|---|---|---|
| Aquatic Life | Phosphorus (Total) | Slightly Bad | The calculated median is from 5 or more samples and is > indicator and the chlorophyll a indicator is exceeded. |
| | pH | Bad | >10%, with a minimum of 2, samples exceed criteria, with 1 or more by a large margin. |
| | Oxygen, Dissolved | Encouraging | There are < 10 samples with 0 exceedances of criteria. More data needed. |
| | Dissolved oxygen satura | Encouraging | There are < 10 samples with 0 exceedances of criteria. More data needed. |
| | Chlorophyll-a | Slightly Bad | The calculated median is from 5 or more samples and is > indicator. |
| Primary Contact Recreation | Escherichia coli | Very Good | Where there are no geometric means, all bacteria samples are < 75% of the geometric mean. Where there are geometric means all single bacteria samples are < the SSMC and all geometric means are < geometric mean criteria. |
| | Chlorophyll-a | Very Good | There are a total of at least 10 samples with 0 exceedances of indicator. |

## WATERSHED LAND USE SUMMARY

Fry, J., Xian, G., Jin, S., Dewitz, J., Homer, C., Yang, L., Barnes, C., Herold, N., and Wickham, J., 2011. Completion of the 2006 National Land Cover Database for the Conterminous United States, PERS, Vol. 77(9):858-864. For larger image contact NHDES.
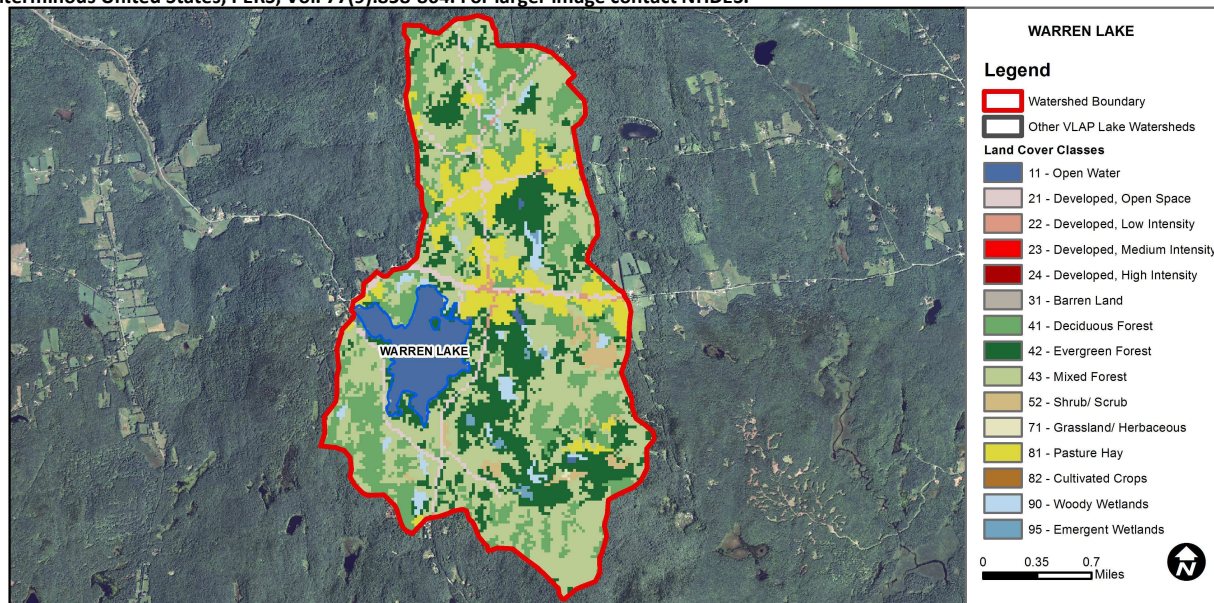


| Land Cover Category | % Cover | Land Cover Category | % Cover | Land Cover Category | % Cover |
|---|---|---|---|---|---|
| Open Water | 6.52 | Barren Land | 0 | Grassland/Herbaceous | 0.04 |
| Developed-Open Space | 3.66 | Deciduous Forest | 19.12 | Pasture Hay | 10.13 |
| Developed-Low Intensity | 0.58 | Evergreen Forest | 19.45 | Cultivated Crops | 0 |
| Developed-Medium Intensity | 0 | Mixed Forest | 35.78 | Woody Wetlands | 2.31 |
| Developed-High Intensity | 0 | Shrub-Scrub | 1.88 | Emergent Wetlands | 0.44 |

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

## OBSERVATIONS AND RECOMMENDATIONS (*Refer to Table 1 and Historical Deep Spot Data Graphics*)

- **CHLOROPHYLL-A:** Chlorophyll levels were elevated from July through September and approached levels indicative of an algal bloom. The 2014 average chlorophyll level was the highest measured since monitoring began and was much greater than the state median. Historical trend analysis indicates relatively stable chlorophyll levels with moderate variability between years.

- **CONDUCTIVITY/CHLORIDE:** Deep spot, Carmen Cove Bk., Colburn Hill Bk., Dam Bk., Pickerel Cove Bk., and Smith Hill Bk., conductivity and chloride levels were less than or approximately equal to the state medians. Historical trend analysis indicates significantly decreasing (improving) epilimnetic (upper water layer) conductivity levels since monitoring began. We hope to see this continue! Conductivity and chloride levels continue to be elevated in Spruce River.

- **E. COLI:** E. coli levels were much less than state standard for public beaches and surface waters at the Boat Landing and Edith's Beach.

- **TOTAL PHOSPHORUS:** Epilimnetic phosphorus levels were average in July, decreased slightly in August, and then increased to slightly elevated levels in September. Low water levels may have concentrated nutrients in the lake in late August/September. Average epilimnetic phosphorus levels remained stable with 2013 and approximately equal to the state median. Historical trend analysis indicates relatively stable epilimnetic phosphorus levels with moderate variability between years; however average phosphorus levels have remained higher since 2005. Hypolimnetic (lower water layer) phosphorus levels were average and stable from July through September. Carmen Cove Bk., Colburn Hill Bk. and Spruce River phosphorus levels decreased from July through September and were within average ranges for those stations. Dam Brook and Pickerel Cove Brook phosphorus levels were elevated in September when tributary flows were low. Smith Hill Bk. phosphorus levels increased slightly from July through September as flow decreased but remained within an average range for that station.

- **TRANSPARENCY:** Transparency was stable from July through September, however it was the lowest measured since monitoring began due to the elevated algal growth. Historical trend analysis indicates significantly decreasing (worsening) transparency since monitoring began. However, transparency measured with the viewscope (VS) in August was much better that that measured without and likely a better representation of actual conditions.

- **TURBIDITY:** Epilimnetic and Hypolimnetic turbidities were elevated from July through September likely due to the elevated algal growth and/or suspended sediments. Carmen Cove Bk. turbidity was slightly elevated on each sampling event but remained stable from July through September. Dam Brook turbidity was elevated and increased from July through September when flows were low.

- **PH:** Epilimnetic and Hypolimnetic pH levels were generally less than the desirable range 6.5-8.0 units. Historical trend analysis indicates relatively stable epilimnetic pH with moderate variability between years. Carmen Cove Bk., Colburn Hill Bk. and Dam Bk. pH levels were within the desirable range. Pickerel Cove Bk., Smith Hill Bk. and Spruce River pH levels were slightly less than desirable.

- **RECOMMENDED ACTIONS:** The elevated algal growth and higher average epilimnetic phosphorus levels in 2013/2014 is concerning. The increased frequency and intensity of storm events combined with low water levels could transport and concentrate nutrients necessary for algal growth. Storm events could also transport sediment, and the already shallow depth of the pond, combined with low water levels and boating traffic could churn up bottom sediments that can also contribute to elevated nutrient levels, algal growth and decreased lake transparency. It is important to educate residents and lake users on good boating practices to minimize impacts to the lake bottom. The improving epilimnetic conductivity trend is a great sign. Spruce River contributes the largest amount of chloride and efforts should be made to try and reduce chloride levels in the River. Keep up the great work!

### Dissolved Oxygen & Temp Profile August, 2014
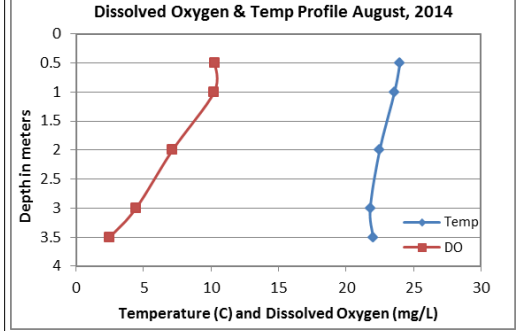


### NH Water Quality Standards: Numeric criteria for specific parameters. Results exceeding criteria are considered a water quality violation.

**Chloride:** > 230 mg/L (chronic)
**E. coli:** > 88 cts/100 mL – public beach
**E. coli:** > 406 cts/100 mL – surface waters
**Turbidity:** > 10 NTU above natural level
**pH:** between 6.5-8.0 (unless naturally occurring)

### NH Median Values: Median values for specific parameters generated from historic lake monitoring data.

**Alkalinity:** 4.9 mg/L
**Chlorophyll-a:** 4.58 mg/m$^3$
**Conductivity:** 40.0 uS/cm
**Chloride:** 4 mg/L
**Total Phosphorus:** 12 ug/L
**Transparency:** 3.2 m
**pH:** 6.6

| Station Name | Table 1. 2014 Average Water Quality Data for WARREN LAKE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Alk. mg/l | Chlor-a ug/l | Chloride mg/l | Cond. uS/cm | E. Coli #/100ml | Total P ug/l | Trans. m | | Turb. ntu | pH |
| | | | | | | | NVS | VS | | |
| Epilimnion | 3.97 | 10.45 | 9 | 54.2 | | 12 | 1.79 | 2.25 | 2.42 | 6.54 |
| Hypolimnion | | | | 55.1 | | 13 | | | 3.06 | 6.35 |
| Boat Landing | | | | | 10 | | | | | |
| Carmen Cove Brook | | | 8 | 56.6 | | 17 | | | 2.15 | 6.75 |
| Colburn Hill Brook | | | 4 | 55.7 | | 10 | | | 0.51 | 6.84 |
| Dam Brook | | | 3 | 41.7 | | 20 | | | 3.09 | 6.87 |
| Edith's Beach | | | | | 6 | | | | | |
| Pickerel Cove Brook | | | 3 | 29.4 | | 17 | | | 0.47 | 6.39 |
| Smith Hill Brook | | | 3 | 17.2 | | 13 | | | 1.00 | 6.01 |
| Spruce River | | | 35 | 155.6 | | 20 | | | 0.81 | 6.48 |

## HISTORICAL WATER QUALITY TREND ANALYSIS

| Parameter | Trend | Explanation | Parameter | Trend | Explanation |
|---|---|---|---|---|---|
| Conductivity | Improving | Data significantly decreasing. | Chlorophyll-a | Stable | Trend not significant; data moderately variable. |
| pH (epilimnion) | Stable | Trend not significant; data moderately variable. | Transparency | Worsening | Data significantly decreasing. |
| | | | Phosphorus (epilimnion) | Stable | Trend not significant; data moderately variable. |

### Historical Trend Epilimnetic Conductivity and pH



### Historical Deep Spot Chlorophyll-a, Epilimnetic Total Phosphorus & Transparency Data